The distribution of molecular markers within laboratory grown evaporite minerals

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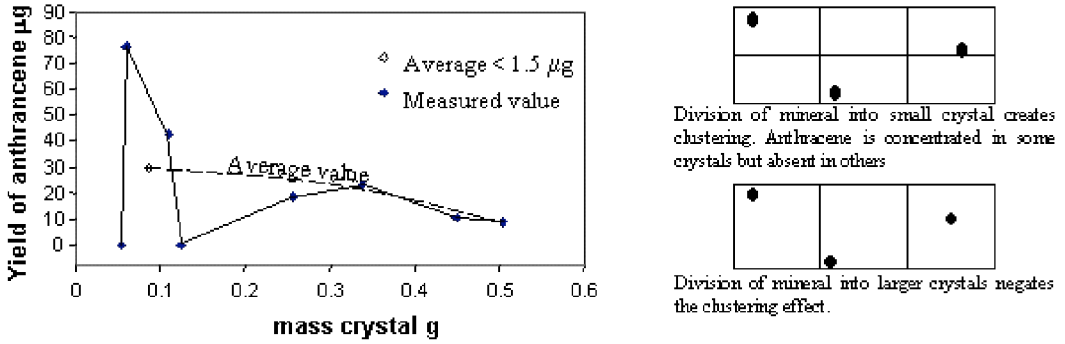
Crystals of halite and epsomite, minerals representative of the types that form evaporite deposits, have been grown in the laboratory and organic compounds have been incorporated within. These crystals form part of an ongoing study to develop an extraction method for a LOAC-SERRS (Lab on a Chip Surface Enhanced Resonance Raman Spectroscopy) system to detect small quantities of molecular biomarkers in aqueous fluid inclusions in Martian evaporite minerals. The analysis of these crystals has shown that compounds that are water-soluble are abundant in fluid inclusions whereas organic compounds that are only sparsely soluble in water may be distributed throughout the mineral. Sparsely water-soluble compounds may cluster and this can cause an erratic distribution of yields to be observed when sample size is small. These effects should be considered when designing an analytical scheme as they will impact the efficiency of an extraction method.



Graphing showing that the concentration of anthracene present in halite crystals has a great variance in small crystal sizes. This creates a clustering effect

Laboratory and field contamination, are amongst the biggest problems encountered when analysing the small organic content of evaporite minerals. Despite these problems stalagmites, formed by the evaporation of water in caves leading to the precipitation of carbonates[1] and Tertiary-aged halite evaporites[2] have been successfully analysed for their lipid content. However, recent attempts to replicate these studies using different samples have encountered problems because procedural blanks often contain the lipids, and in particular fatty acids, that are expected to be present in the sample (Watson, *pers. com.*; Blyth, *pers. com.*). Using laboratory grown crystals for method development has the advantage that the anthropogenic molecular markers that have been incorporated do not occur within procedural blanks, making it easy to differentiate between the compounds that have been incorporated into minerals from the commonly encountered contaminants. The analysis of standard crystals has shown that encapsulation of molecular markers in an evaporite mineral is readily achieved within the laboratory. Given the work of others described above, this incorporation is probably commonplace in nature but in many instances the quantities of molecular biomarkers preserved in this way are probably extremely small.

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[1] Xie SC., Yi Y., Huang JH., Hu CY., Cai YJ., Collins M., Baker A., 2003. Lipid distribution in a subtropical southern China stalagmite as a record of soil ecosystem response to paleoclimate change. *Quaternary Res* **60** 340-347.
[2] Grice K., Schouten S., Nissenbaum A., Charrach J., Damste JSS., 1998. Isotopically heavy carbon in the C-21 to C-25 regular isoprenoids in halite-rich deposits from the Sdom Formation, Dead Sea Basin, Israel. *Org Geochem* 28 349-359.